We claim:

1. A thermal barrier coating comprising rare-earth element phosphate.

2. The thermal barrier coating according to Claim 1 further comprising a monazite or xenotime crystal structure.

3. The thermal barrier coating according to Claim 1, wherein the ratio between rare-earth element and phosphate is about 1:1.

4. The thermal barrier coating according to Claim 1 having a thickness between 10 and 500 micrometers.

5. The thermal barrier coating according to Claim 1 deposited on a substrate having a temperature between 600°C and 1100°C.

6. The thermal barrier coating according to Claim 5 deposited on a substrate having a temperature between 750°C and 950°C.

7. The thermal barrier coating according to Claim 1 formed by a process selected from the group consisting of chemical vapor deposition, physical vapor deposition, electron beam evaporation, pulsed electron beam evaporation, laser ablation, and plasma spraying.

8. The thermal barrier coating according to Claim 7 using single or multiple sources of materials selected from the group consisting of rare-earth phosphates and mixtures of rare-earth precursors with phosphorous precursors.

9. The thermal barrier coating according to Claim 1 formed with a columnar microstructure.

10. The thermal barrier coating according to Claim 1 formed with a porous microstructure.

11. The thermal barrier coating according to Claim 1, wherein the phosphate is lanthanum phosphate.

12. The thermal barrier coating according to Claim 1 deposited on one of a ceramic substrate and a metallic substrate.

13. The thermal barrier coating according to Claim 12, wherein the metal substrate is a nickel-based superalloy, an iron-based superalloy or a cobalt-based superalloy.

14. The thermal barrier coating according to Claim 13 further comprising a layer of aluminum phosphate disposed between the rare-earth element phosphate and the metal substrate.

15. The thermal barrier coating according to Claim 13 further comprising a layer of alumina between the metallic substrate and said rare-earth element phosphate.

16. The thermal barrier coating according to Claim 15 further comprising a region of rare-earth aluminate between the alumina and said rare-earth element phosphate.

17. The thermal barrier coating according to Claim 1 comprising a mixture of lanthanum phosphate, cerium phosphate and neodymium phosphate.

18. A thermal barrier coating comprising lanthanum phosphate.

19. The thermal barrier coating according to Claim 18 further comprising a monazite crystal structure.

20. The thermal barrier coating according to Claim 18, wherein the ratio between lanthanum and phosphate is about 1:1.

21. The thermal barrier coating according to Claim 18 having a thickness between 10 and 500 micrometers.

22. The thermal barrier coating according to Claim 18 deposited on a substrate having a temperature between 600°C and 1100°C.

23. The thermal barrier coating according to Claim 22 deposited on a substrate having a temperature between 750°C and 950°C.

24. The thermal barrier coating according to Claim 18 formed by a process selected from the group consisting of chemical vapor deposition, physical vapor deposition, electron beam evaporation, pulsed electron beam evaporation, laser ablation, and plasma spraying.

25. The thermal barrier coating according to Claim 24 using single or multiple sources of materials selected from the group consisting of rare-earth phosphates and mixtures of rare-earth precursors with phosphorous precursors.

26. The thermal barrier coating according to Claim 18 formed with a columnar microstructure.

27. The thermal barrier coating according to Claim 18 formed with a porous microstructure.

28. The thermal barrier coating according to Claim 18 deposited on one of a ceramic substrate and a metallic substrate.

29. The thermal barrier coating according to Claim 28, wherein the metal substrate is a nickel-based superalloy, an iron-based superalloy or a cobalt-based superalloy.

30. The thermal barrier coating according to Claim 29 further comprising a layer of aluminum phosphate disposed between the lanthanum phosphate and the metal substrate.

31. The thermal barrier coating according to Claim 29 further comprising a layer of alumina between the metallic substrate and the lanthanum phosphate.

32. The thermal barrier coating according to Claim 31 further comprising a region of lanthanum aluminate between the alumina and the lanthanum phosphate.

33. The thermal barrier coating according to Claim 18 comprising a mixture of lanthanum phosphate, cerium phosphate and neodymium phosphate.

34. A thermal barrier coating comprising a mixture of rare-earth element phosphates and refractory oxides.

35. The thermal barrier coating according to Claim 34 having a thickness between 10 and 500 micrometers.

36. The thermal barrier coating according to Claim 34 deposited on a substrate having a temperature between 600°C and 1100°C.

37. The thermal barrier coating according to Claim 34 formed by a process selected from the group consisting of chemical vapor deposition, physical vapor deposition, electron beam evaporation, pulsed electron beam evaporation, laser ablation, and plasma spraying.

38. The thermal barrier coating according to Claim 34 formed with a columnar microstructure.

39. The thermal barrier coating according to Claim 34 formed with a porous microstructure.

40. The thermal barrier coating according to Claim 34 deposited on one of a ceramic substrate and a metallic substrate.

41. The thermal barrier coating according to Claim 40, wherein the metal substrate is a nickel-based superalloy, an iron-based superalloy or a cobalt-based superalloy.

42. The thermal barrier coating according to Claim 41 further comprising a layer of aluminum phosphate disposed between the mixture and the metal substrate.

43. The thermal barrier coating according to Claim 41 further comprising a layer of alumina between the metallic substrate and the mixture.